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Physico-chemical Characterization of Industrial Effluents From The Town of Ouargla (South East Algeria)

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Abstract

In order to preserve the quality of our environment and public health, regulatory treatment of pollutants is constantly changing to more restrictive standards. Thus, the problem of organic pollutants has emerged as a major issue in the treatment of industrial wastewater (ERI). The objective of this work was the evaluation of the above organic pollution load of wastewater from some industrial sites in the city of Ouargla (Algeria). The water samples were collected from seven different sites, hospital, washing stations, a slaughterhouse and a processing plastic plant. The physico-chemical characterization of raw sewage revealed that these releases are loaded with organic matter in terms of COD (153.6 to 36120 mg/L) BOD_5 (100 to 4700 mg/L) TSS (29 to 14702 mg/L). For the majority of the studied parameters, Algerian industrial waste often exceeded the required standards, since wastewater has a high organic load (BOD_5 / COD = 0.012 to 0.45 and TSS / BOD_5 = 0.2625 to 73.51, COD / BOD_5 = 2.23 to about 80000), showing in most cases poor biodegradability.

Selection and peer-review under responsibility of the Euro-Mediterranean Institute for Sustainable Development (EUMISD)

Keywords: Ouargla, organic pollution, industrial wastewater, chemical oxygen demand, biological oxygen demand, biodegradability

1. introduction

The Ouargla region (South East Algeria) experienced various problems related to water, including discharges of wastewater containing pollutants in the receiving environment without any treatment. This issue is a matter of increasing concern given the side effects that pollutants can cause environmental and health problems.
Effluents polluted by organic matter from several sites in the city of Ouargla appeared highly loaded by non-biodegradable organic matter, and hence require a significant effort to find economic methods to reduce this pollution.

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The effective treatment of liquid waste requires, first, a good knowledge of the quantity, quality and temporal variations in the composition of the effluent. In the identification of wastewater, the physico-chemical characterization is essential to finely define the characteristics of a treatment process. In addition, knowledge of some physicochemical parameters provides a preliminary assessment of the quality and the degree of pollution of water [1, 2]. The objective of this study is therefore the characterization and the quantification of the above organic pollution (TSS, COD, BOD5, ...) in industrial wastes from the city of Ouargla. Indeed, the first step in the fight against industrial pollution is the measurement and control for an identification of the causes of this pollution and a better understanding of [3].

2. Materials and methods

2.1. Presentation of the study area

The province of Ouargla is located in the south-east of Algeria; it is distant 800 km from the capital and covers more than 163,233 km^2. The geographical coordinates of the region are: Average altitude: 134 m, Lat: 31 ° 58 'North Longitude: 5 ° 20 'East [3]. The urban drainage network in the city of Ouargla is unitary. It currently covers three municipalities: Ouargla, Rouissat and Ain Beida; it is based on 66 pump stations (lift and discharge). There are two kinds of consolidation, the majority of citizens are connected to the sewer system, but there are sewerages by the autonomous mode. Currently, raw sewage is directed to a wastewater treatment plant (Said Utba) lagoon by repression, and undergoes the various conventional treatments of an urban effluent. The treated wastewater is discharged by gravity to the transfer channel to Sebkhat Safioune (STEP Ouargla, 2009).Our work focused on the release of the hospital, a slaughterhouse, 3 washing stations and a factory. Wastewaters from these sites are discharged into the sewerage system without any treatment

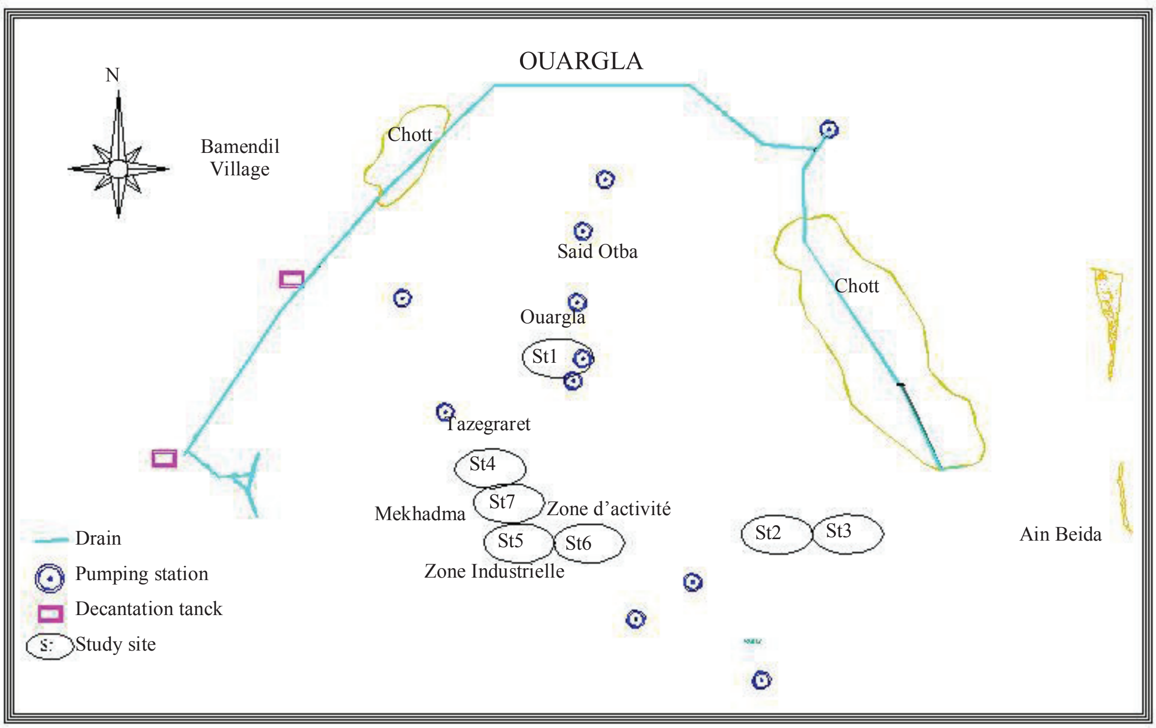

Fig.1. Location of the studied sites in the city of Ouargla

The seven selected sites are located in the city of Ouargla (numbered from 1 to 7) or just across Ouargla (Fig.1). This together with a population of 100,693 inhabitants (estimated in 2006), is the greater part of the city of Ouargla, it includes the neighborhoods of: Beni Thour, Boughoufala Sidi Amran, part of Mekhadma, City Centre, Gara North Tazegrarte, part of Gherbouz and the southern part of Ksar [3,4].

2.2. Sampling

Due to the complexity and the diversity of discharges, it is difficult to make a judicious choice of sampling points. However, the results of a literature review and a previous survey pointed out the sites releasing effluents loaded with organic matter and allowed to select the seven sampling points.

The site (1) corresponds to wastewater Hospital Boudiaf taken from the last look at noon. The amount of wastewater discharged by Mohammed Boudiaf's hospital is estimated to 7882.2 L/day on average. It consists of detergents, alcohol, antibiotics, etc.. The evacuation was carried out in the sewer system.

Sites (2, 3, 4) are related to wastewater of three stations washing vehicles taken from pits washing at noon. Their releases are primarily responsible for oils, fats and detergents.

Sites (5, 6) correspond to the slaughterhouse wastewater from the town of Ouargla, taken from the first and last looks that are separated by a settling pond. Sampling was done after slaughter for the first hours of the day (seven to eight hours). The effluents of these releases contain wash water of: soil, lairage, blood, etc.. [5,6].

The site (7) is on a wastewater processing plastic plant collected at eleven o'clock from a basin of water discharge after use in a cooling circuit in the process of making plastic samples. The wastewater sites studied are performed at 3 different periods: June, October and November-December 2010, in very clean brown borosilicate glass bottles, rinsed at the time of employment with the test water. Carefully labeled samples are transported to the laboratory within a period not exceeding 24 hours [7].

2.3. Analysis of wastewater

Table 1.The parameters studied and the methods of analysis

Parameters	Methods of analysis	Units	Sources
Temperature	pH meter brand PHB-1 cell	°C	Analyse de l'eau, Rodier, 2005[7]
pH	pHmetre brand PHB-1 cell	_	Analyse de l'eau ,Rodier, 2005[7]
Conductivity	Conductimeter type (WTW LF330/Tetra Con® 325, and type J DDS-308A)	µs/cm	Analyse de l'eau, Rodier, 2005[7]
Material suspended	Filtration on filter paper	mg/l	Norme EN 872:1996[9]
COD	Method by oxidation with $KMnO_4$	mg/l	Norme NFT 90-101[7,8,9,10]
BOD_5	Instrumental method	mg/l	Analyse de l'eau aspect réglementaires et techniques, F.Rejsek, 2002[9]

Physico-chemical analyses of industrial wastewater from the considered region were conducted in the laboratory of biogeochemistry desert environments (University of Ouargla), according to the list given in Table 1.

3. Results and discussion

The results of physico-chemical analyzes of wastewater of the studied sites are presented in Table 2.

Table 2. Physico-chemical analysis of wastewater at different periods of the studied sites

Parameter	Period	Norm	ST1	ST2	ST3	ST4	ST5	ST6	ST7
T (°C)	June 2010		26	26	26	26	24	24	24
	October 2010	30	19.6	27.7	27.9	26	25.1	25	-
	Nov-Dec 2010		22.2	22.4	23.2	21.7	16.5	16.1	-
pH	June 2010		6.65	6.63	6.79	6.76	6.36	6	7.57
	October 2010	5.5-8.5	7.08	6.33	6.79	6.8	5.67	5.81	-
	Nov-Dec 2010		7.86	6.66	7.39	6.88	8.02	8.07	-
CE(ms/cm) à 25	June 2010		4.35	6.54	6.59	6.57	5.39	5.19	2.99
	October 2010	2.5	4.55	6.83	25.32	44.95	24.24	23.16	-
	Nov-Dec 2010		3.98	6.59	0	6.54	10.44	10.60	-
TSS (mg/l)	Nov-Dec 2010	40	29	716	14702	105	933.33	696.66	-
COD (mg/l)	June 2010		422.4	1344	1504	1152	4531	2343	154
	October 2010	130	691.2	36120	20781	3463	18307	9024	-
	Nov-Dec 2010		223.01	1357	1891	1018	2069	1600	
BOD5 (mg/l)	October 2010	40	150	2350	250	500	4700	3500	-
	Nov-Dec 2010		100	350	200	400	360	317	-
COD/ BOD5	October 2010	-	4.61	15.37	83.12	6.93	3.9	2.58	-
	Nov-Dec 2010		2.23	3.88	9.45	2.55	5.75	5.1	-
TSS/BOD5	Nov-Dec 2010	-	0.29	2.1	73.5	0.26	2.6	2.2	-

In all analyzes, it appears that most of the measured values do not meet standards Algerian discharge of industrial wastewater. It can be also noted that there is considerable heterogeneity in the results, showing variations of the degree of pollution from one site to another.

Temperature is a key factor in biological activity, since microorganisms can be psychrophilic, mesophilic or thermophilic [11]. Referring to the standard limits for the emissions of industrial discharge (table 2), it can be noted that the measured temperatures were below 30 ° C, considered the Algerian standard industrial waste [5, 11]. The temperature variation from one site to another and from one sample to another is due to weather conditions and time of sampling but zonal ecosystem may also be involved [7]. The pH is also one of the most important factors affecting the biological activity of the microflora of the water; the majority of microorganisms growing in the range 4.5-8 with an optimum between 5.5 and 7.5. Moreover, pH is an important element in the interpretation of corrosion in piping installations for the treatment and must be closely monitored during all treatment operations. The average pH values of the wastewater of the different sampling sites were generally between 5 and 9 (Table 2). For slaughter, the values varied of 5 to 8. These variations are related to overdose cleaner acid-base [12]. The acidity noted for these waters was caused by the degradation of organic substances, and can lead to corrosion of concrete or metal pipe with training of lead for example [7]. A neutral pH of 7.2 and 7.57 was recorded for the hospital and processing plastic industry respectively, and an acidic pH for washing stations due to degradation of the organic material existing under the oily suspension in anaerobic conditions. [7]. The electrical conductivity is probably one of the simplest and most important for the quality control of wastewater; it reflects the overall degree of mineralization, and informs about the salinity. Table 2 revealed that electrical conductivity varied from one site to another and one campaign to another also. The value recorded for the hospital was fairly stable during the three campaigns. The average value for this site was 4.29 mS/cm. The lower value was noticed for the plastic factory processing water, 2.99 mS/cm. Extremely large values were recorded during the second campaign for sites 3, 4, 5 and 6, namely 25.32, 44.95, 24.24 and 23.16 mS/cm respectively, but most was recorded for site 4 (carwash 3). This change in the electrical conductivity came from the salt load of water supply. This is why the slaughterhouse, the car wash (3) have EC values greater than 5 ms/cm, because their feed is by drilling Mekhadma, which was the most salt drilling in the bowl of Ouargla; While the hospital was supplied by the drilling of the hospital and washing stations 1 and 2 by the Beni thour drilling. It may also be caused by the use of detergents and cleaning products. To assess the quality of water, it is always necessary to quantitatively evaluate its load of dissolved and particulate material. The calculation results of suspended solids (TSS) shows that only one site, the hospital (29 mg/L) did not exceed the threshold of acceptable values, limited to 30 mg/L (Table 2). Other sites have a variation between 105 and 14702 mg/L. The highest value was found in the car wash (2) due to heavy oils of large molecular weight (Table 2).

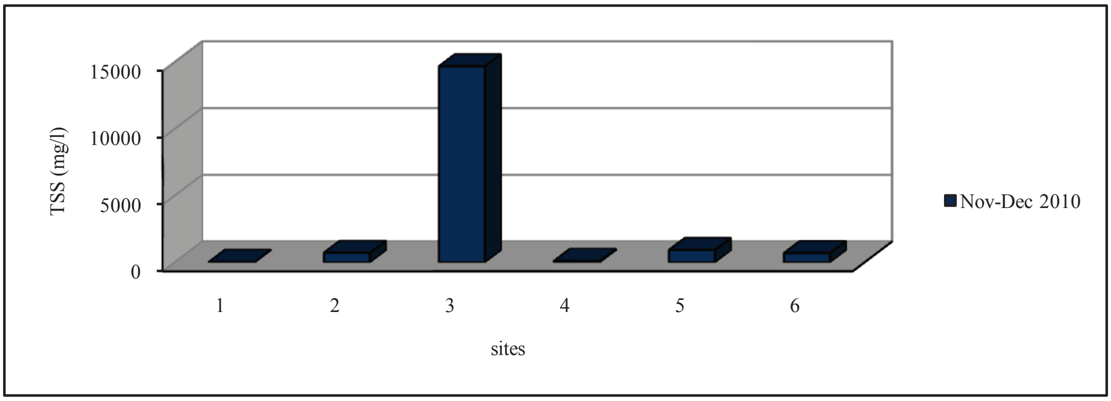

Fig.2. Levels of suspended solids in water from the different studied sites.

The slaughterhouse shows considerable values 933 mg/L for the first point and 696.66 mg/L for the second; this material was composed by feces and fats of high molecular weights. The decrease in the value of TSS of point 1 and 2 resulted from the accumulation of these materials in the sedimentation basin placed between the two points, but it can be noted that it did not have a high impact. The presence of the TSS in different discharges may affect significantly the operation of the sewer system. On the other hand, it can cause dangerousness as sludge deposits can lead to clogging the aquatic fund receivers. The settled sludge can have a negative impact on the conservation of natural biological structures and hence on micropollutants biodegradation [11].

The chemical oxygen demand is the amount of O_2 consumed by oxidizable matter (reducing) under defined conditions. According to the results, very high values especially for washing stations and slaughter during the second campaign can be observed from Fig.3. Values were above the standard limits for industrial waste, namely a COD value of 120 mg/L [11]. They range from 153.6 mg/L for the processing Plastic plant to 36120 mg/L for the car wash (1). The hospital has an average value of 445.54 mg/L caused by oxidation and pharmaceuticals used for analysis and medicinal treatments and also for cleaning.

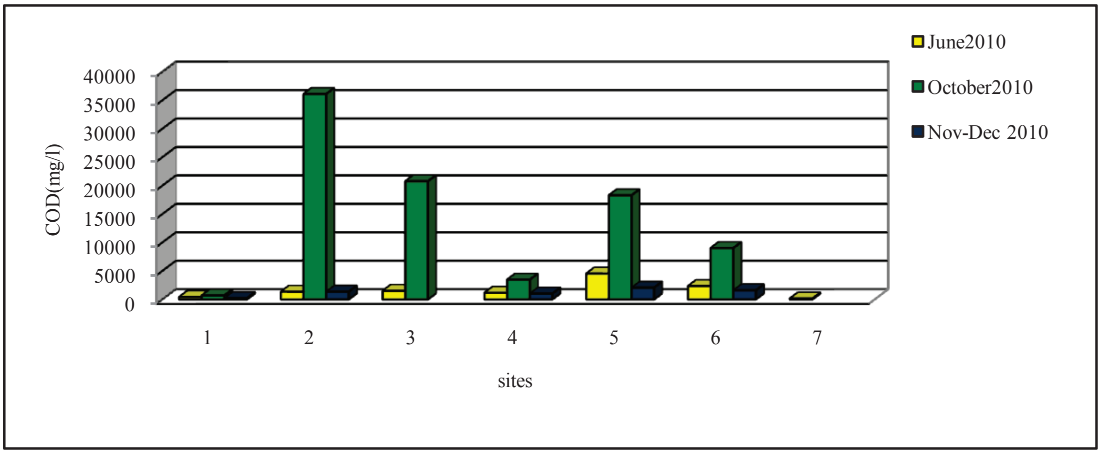

Fig.3.COD values of water from the various studied sites

Large values of 12940, l8058 and 1877 mg/L were recorded for the washing stations, respectively. These values should be related to the presence of large amounts of machine oil and detergents. Production and pollution levels of these compounds are often important at the end of the working period. Note that some of these discharges are casual and can be, for example, accidental leakage of product during handling or storage [13]. The first and the second point of the slaughterhouse showed COD values of 8302 and 4322 mg/L, reflecting the oxidation of these waters rich in organic matter. These values appeared to be very high. Nuisance in the receiving environment are noticeable if there is a high intake of organic matter in the wastewater

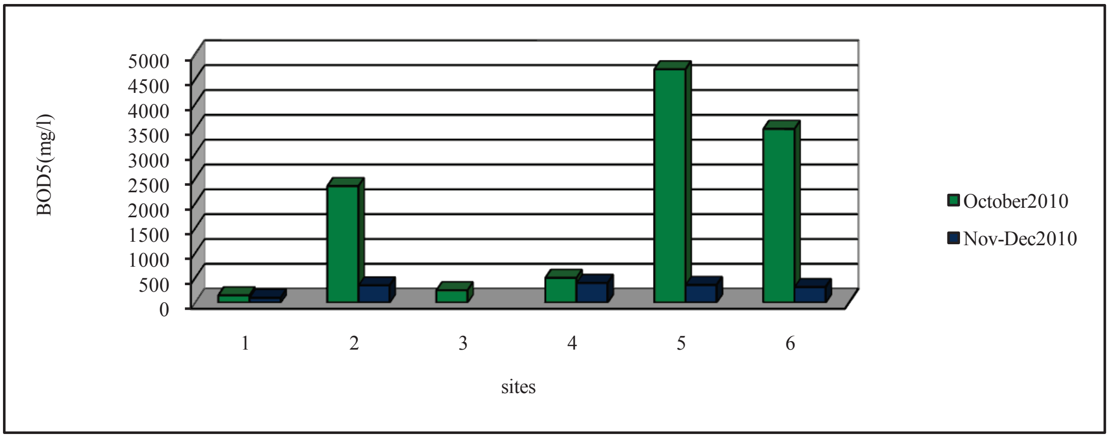

Fig .4.Values of BOD_5 of water from the different studied sites.

Biological oxygen demand is the amount of oxygen (mg/L) consumed in five days at 20°C in the dark. High BOD_5 values were found for all sites, between 100 and 4700 mg/L, exceeding the allowable standard industrial waste limits (40 mg/L). The lowest value was that of the hospital, 100 and 150 mg/L at the second and third campaign respectively, this low value reflects a low microbial activity due to the existence of some antimicrobial agents (eg drugs) that inhibit their activity. BOD_5 values were high for carwashes, 350 and 2350 mg/L for the carwash 1, 200 and 250 mg/L for the carwash 2 and, 400 to 500 mg/L for the carwash 3. The samples of washing station were loaded with oils, but in these areas the values obtained indicate the existence of microbial activity. The amount of oil spilled did not completely inhibited microbial activity, such as found in anaerobic conditions. The largest BOD_5 values were recorded for the slaughterhouse, 360 and 4700 mg/L for the first point and 317 and 3500 mg/L for the second point (Fig .4). High values of BOD_5 could be explained by the abundance of organic matter (rumen debris) and the concentration of blood in the effluent [6].

3.1. Evaluation of organic wastewater pollution

For a better understanding of the pollution, determination of COD/BOD_5 and TSS / BOD_5 ratios are of a high importance. The use of these characterization parameters is a good way to give a picture of the degree of pollution of raw sewage and also to optimize the physicochemical parameters of the wastewater in order to propose a suitable mode of treatment.

3.1.1. COD/BOD_5 ratio

The COD/BOD_5 ratio characterizes the biodegradability of the considered effluent. It can be inferred if the wastewater discharged directly into receiving waters has characteristics of domestic wastewater (COD/BOD_5 ratio of less than 3). The elevation of this ratio indicates an increase of non-biodegradable organic materials [7]. The highest values were found for washing stations, especially for the station (2), which showed a very high value 83for the second campaign and 9.5 for the third. These values were far from the standard ratio of urban wastewater effluent indicating a low biodegradability. Wastewaters from the slaughterhouse have a ratio of COD/BOD_5, ranging from 2.5 to 5. These values were close to the value of the standard ratio for urban The COD/BOD_5 ratio characterizes the biodegradability of the considered effluent. It can be inferred if the wastewater discharged directly into receiving waters has characteristics of domestic wastewater (COD/BOD_5 ratio of less than 3). The elevation of this ratio indicates an increase of non-biodegradable organic materials [7]. The highest values were found for washing stations, especially for the station (2), which showed a very high value 83for the second campaign and 9.5 for the third. These values were far from the standard ratio of urban wastewater effluent indicating a low biodegradability. Wastewaters from the slaughterhouse have a ratio of COD/BOD_5, ranging from 2.5 to 5. These values were close to the value of the standard ratio for urban wastewater. It can be therefore concluded that even if the considered wastewaters have a high organic load, they are moderately biodegradable. Examination of this ratio clearly emphasizes the biodegradability of wastewater from the slaughterhouse to which biological treatment seems quite suitable [6]. Wastewaters from the hospital have quite a biodegradable character with values between 2.23 and 4.6. There is a trend towards degradation of chemicals such as detergents (Table 2). It can be concluded that the low biodegradability of these industrial wastewater can be attributed to the presence of some inhibitory products, such as oil, grease, phenols, some antimicrobial agents (drugs) or a significant load of organic matter.

3.1.2. TSS / BOD_5 ratio

The BOD_5 / COD ratios of the hospital and the slaughterhouse appeared quite high, confirming that drained the sewage of these sites were heavily loaded with organic matter. This result was confirmed by the average ratios of MES / BOD_5 of 0.29 for the hospital and 2.4 for the slaughterhouse. In addition, the quite low COD/BOD_5 ratio showing that the organic matter load in the wastewater of these sites was moderately biodegradable [6].

4. Conclusion

The amount of pollutants introduced into the environment through sewage systems puts undoubtedly endanger the ecological balance if the wastewaters from different sources are not treated prior to disposal or reuse. Among these pollutants, organic pollutants have been considered in this work. Indeed, negative impacts are observed on receptors such as deoxygenation of the medium due to inputs of organic matter, microbiological contamination due to the contribution of pathogens, and chemical pollution associated with mineral and organic micropollutants.

Understanding the transfer of pollutants in a sewage system is primarily through the knowledge of their mode of introduction; the establishment of a global diagnosis of water sampling from different sites was therefore the purpose of this work.

A first observation can be made through the obtained results (average values found in TSS, BOD_5 and COD), the presence of a strong and irregular organic pollution from industrial wastewater from the town of Ouargla could be dangerous to the receiving environment. In addition, a mineral pollution was shown from the high values of the electrical conductivity.

It is necessary to use further analysis by other techniques to refine this characterization and to improve the identification of the possible contamination sources. The use of chromatography coupled spectroscopic technologies seems to be appropriate for a better characterization, both qualitative and quantitative.

Rational management of water resources and the establishment of systems for the purification of wastewater from Ouargla seem essential to minimize the environmental risks associated with the release of wastewater in the receiving environment. It would be interesting to complete rational management of water resources and the establishment of systems for the purification of wastewater from Ouargla seem essential to minimize the environmental risks associated with the release of wastewater in the receiving environment. It would be interesting to complete this work by the assessment of columns of activated carbon and sand dune designed for the removal of organic pollutants in aqueous media.

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